

DEVELOPMENT OF THE SELF- LEARNING MACHINE FOR CREATING MODELS OF MICROPROCESSOR OF SINGLE-PHASE EARTH FAULT PROTECTION DEVICES IN NETWORKS WITH ISOLATED NEUTRAL VOLTAGE ABOVE 1000 V

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Abstract - *The paper proposes the development of a self-learning machine for creating models of microprocessor-based single-phase ground fault protection devices in networks with an isolated neutral voltage higher than 1000 V. Development of a self-learning machine for creating models of microprocessor-based single-phase earth fault protection devices in networks with an isolated neutral voltage higher than 1000 V. allows to effectively implement mathematical models of automatic change of protection settings. Single-phase earth fault protection devices.*

Key words - *voltage, network, neutral, insulation, conductivity, error.*

I. INTRODUCTION

One of the most important issues in the electric power industry today is the problem of improving the reliability of power supply and electrical safety in the operation of electrical installations. This condition is associated with the physical and moral aging of most of the equipment, as well as a low level of technical perfection of relay protection and automation.

The prevailing type of damage in 6-10 kV electric networks is single-phase earth faults, which constitute about 75% of the total number of injuries. The duration of the action of single-phase earth fault leads to phase-to-phase and multi-place short circuits.

In many cases, the cause of the closure and further development of the accident is the wear and tear of the electrical insulation of the network. Conditions for electrical safety and reliability of energy supply are largely determined by the state of insulation, its resistance and capacity relative to the ground. Therefore, timely detection and elimination of defects accompanied by a change in the active and capacitive

components of conductivity of insulation will prevent most of the damage.

Current methods for determining insulation parameters for measurements require the involvement of personnel to connect additional capacitive conductivity and additional active conductivity to the electrical network, visual removal of voltage modules, manual calculation of insulation parameters, which leads to a reduction in the level of electrical safety of personnel engaged in determining the current single-phase earth fault.

Modern directional protection against single-phase earth faults has a low sensitivity and a large number of false positives. In this case, disconnections are often of a group nature, and it is difficult to find a damaged feeder in the distribution network, as a result of which a single-phase ground fault can become a more dangerous type of fault - two-phase and three-phase. The main drawback of existing protection against single-phase earth faults is the difficulty in selecting the set-point of the pick-up current, since during the operation of the network the number of simultaneously operating connections changes, and consequently the current of the single-phase earth fault also changes. The existing protections do not take into account the position of the automatic switchover sectionalizer, since during sectioning the value of the real current of a single-phase earth fault will also depend on the parameters of the outgoing lines of the connected section and the number of equipment connected to them. Thus, fixed setting of the single-phase earth fault current does not ensure the selectivity of the protection operation when the number of connections in the load node is switched on.

On the basis of the foregoing, it follows that the task of improving the reliability of the internal power supply system of industrial enterprises and ensuring the growth of the level of electrical safety in the operation of electrical installations is the development of microprocessor-based methods and means of automatic determination of insulation parameters and centralized protection against single-phase earth faults with automatic change of the current set point and with a sectional automatic switchover switch in electric networks with voltage 6 - 10 kV power industrial, mining and rural enterprises, is relevant and has important scientific and practical significance [3, 5 - 10].

II. THE MAIN POINTS OF THE SELF-LEARNING MACHINE WHEN DEVELOPING MODELS OF MICROPROCESSOR-BASED SINGLE-PHASE EARTH FAULT PROTECTION DEVICES IN NETWORKS WITH ISOLATED NEUTRAL VOLTAGE ABOVE 1000 V

At present, the introduction of more sophisticated selective protection devices for single-phase earth fault protection based on the use of one of the known methods of operation of these devices can only to a certain extent improve the situation in 6-10 kV networks in enterprises.

The existing methods for determining the regime of the current-preceding single-phase earth fault are not unique. This is due to the fact that the magnitude of the earth fault current and its nature depends on the network parameters, the neutral operation mode, the transient resistance at the fault location and the number of connected voltage transformers.

To date, the most promising technical means of automation are microprocessor means. Therefore, it seems expedient to develop automatic protection systems against single-phase earth faults based on microprocessor means. Therefore, more significant changes can be achieved when developing and implementing microprocessor devices, including multifunctional ones, whose output information would be the result of analyzing the single-phase earth fault process for several factors.

The mathematical model of microprocessor devices, as well as any other digital devices, are finite state machine. At the same time, modeling of such systems consists in the synthesis of finite state machine, which is in an objective correspondence with the real system of protection. However, under the conditions of constantly changing random external influences (which is typical for real open systems), static deterministic machine cannot serve as an adequate model of real objects. The most optimal model of such objects can be self-learning stochastic machine. The main functions of such kind of machines are the accumulation of information about the object, the analysis of the obtained data and the correction of the algorithm of its functioning based on the results of data analysis. Given the random nature and the degree of reliability of the accumulated data, the Monte Carlo method can be used for their analysis, which is widely used to solve certain statistical problems that cannot be analyzed analytically [1, 2, 4].

However, before talking about self-learning machines, it is necessary to understand what the learning process is.

Perhaps the following definition: "Learning is a change in behavior or functioning based on information about the outside world. At the same time, the change must occur in the direction of improving behavior or action in the desired direction. " An essential component of learning is the memorization (accumulation) of information.

The concept of "training of system (machine)" is defined as follows:

The training of the system consists in accordance with previous successes or failures (experience), it improves the internal model of the external world.

In this connection, two types of self-learning systems (machines) are possible.

1. A self-learning automatic system is a learning machine or a self-adaptive system whose control algorithm changes in accordance with the evaluation of the control results so that over time it improves its characteristics and the quality of functioning. In general, the design and construction of technical systems is possible only on the basis of the initial a priori information about the nature of processes occurring in the system and the conditions accompanying the operation of the system and exerting a disturbing influence on it. When there is complete initial a priori information, it is possible to accurately determine such values of the characteristics of the system being designed, which ensure a given quality of its functioning; In this case, there is no need for its training. In the absence of complete initial information, the only way to create a system with a given quality of functioning is to use the training principle in its development.

Training is the process of repeated influences on the system and the correction of its reactions to these impacts. External adjustment, or, as it is also called, "encouragement" and "punishment", is carried out by the "teacher" who knows the desired reaction to certain influences. "Teacher" can be either a person - an operator, or a machine. It is on the basis of the processing of the control (a posteriori) information that the missing initial information is replenished. If training is carried out without an external training device, then such a system is called self-learning.

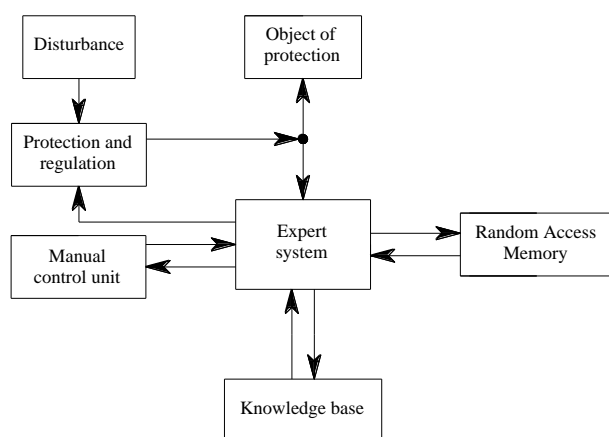
Training is carried out by using algorithms, depending on whether the learning automatic system is discrete or continuous, and represent a system of stochastic difference or stochastic differential equations. Training algorithms are implemented by means of computer technology - digital or analog computers (in particular, by electro integrators) or, finally, by hybrid computer systems. As learning, the self-learning automatic system accumulates experience, on the basis of which the required system response to external influences is gradually developed; The self-learning automatic system is an asymptotically optimal system, because the optimal response of the system to external disturbances is not achieved immediately, but over time, as a result of training.

2. The self-learning system is a self-adjusting system whose functioning algorithm is developed and improved in

the process of self-learning. This process is reduced to "samples" and "mistakes". The system performs trial changes to the algorithm and simultaneously monitors the results of these changes. If the results are favorable in terms of management objectives, the changes continue in the same direction until the best results are achieved or until the management process deteriorates. Self-learning systems include as a private kind of search self-tuning systems.

Any self-learning machine has the ability to model. The system has the ability to model if it defines reactions to its various (models) actions with the help of the conducted external world model, before taking any action, directed to the outside and performs only those actions, which cause the desired reaction of the external world.

To implement the above, we present the block diagram of a model of a microprocessor-based single-phase earth fault protection system in networks with an isolated neutral voltage higher than 1000 V which can be represented as follows:



The whole Model is presented in the form of the following theses:

1. The model of a microprocessor system is a finite abstract self-learning machine with a nondeterministic input alphabet.
2. Data on the object are divided into two types:
 - current - "short-lived" accumulated in the operative memory and subjected to continuous analysis;
 - accumulated (knowledge) - "long-lived" accumulated as a result of analysis of current data, stored in permanent memory and periodically analyzed.
3. The duration of the time interval between two successive procedures for the removal of information about the protection object is directly dependent on the accumulated knowledge (the results of the analysis of current data);
4. Based on the analysis of all data about the object, the model changes its logical structure (the functioning algorithm).
5. Mandatory presence of a model (variable or unchangeable) of an ideal protection object.

In accordance with the block diagram of the microprocessor protection system model from single-phase earth fault, it is possible to build automatic monitoring systems for capacitive fault currents in 6-10 kV networks of power, industrial, mining and rural enterprises with the following advantages:

- simplicity of construction of control units providing speed and sensitivity in single-phase ground-fault mode;
- multifunction, which allows you to combine several different protections in one device, the ability to register processes and events, as well as the location of the damage;
- easy installation and operation, as well as a significant reduction in the time for testing terminals using special tools and data processing programs and adjustment of microprocessor devices;
- wide diagnostic system with reporting of a malfunction;
- a variety of types of human-machine communication that brings the microprocessor device closer to the user, regardless of its location;
- the creation of flexible structures that enable the integration of microprocessor-based protection and automation devices in the Automated Process Control System.

III. CONCLUSION

The development of a self-learning machine in creating models of microprocessor protection devices from single-phase earth faults in networks with an isolated neutral voltage higher than 1000 V makes it possible to effectively implement mathematical models of automatic changes in protection settings.

Development of microprocessor-based methods and means of automatic and centralized protection against single-phase earth faults with automatic change of the electric current setting and with a sectional switch of automatic reserve input in 6-10 kV of electric networks of power, in industrial, mining and rural enterprises, provide increased reliability of the internal power supply system of the enterprise and ensuring the growth of the level of electrical safety in the operation of electrical installations.

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